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WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

CONCEPTUAL DESIGN
INTERIM REPORT
AUGUST 1985

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Project Design Engineer

PINE COULEE RESERVOIR - CONCEPTUAL DESIGN

This memorandum serves as an interim report on conceptual design of the Pine Coulee Reservoir within the context of the feasibility study of water storage of the Willow Creek basin.

1) Data and Information Available

- 1984 Preliminary Planning Study Report, provided by Planning Division.
- 1:5000 and 1:2000 Scale Contour Maps, provided by Survey Branch.
- Level I Hydrology Report and Natural Flow for Willow Creek Basin provided by Hydrology Branch.
- Minimum Freeboard Against Wave Run-up, provided by River Engineering.
- Foundation Investigation and Slope Stability Analysis, provided by Geotechnical Branch.

2) Structures Arrangement

The structures arrangement as shown on drawings, follows the same arrangement as proposed in the planning report, consisting of an embankment dam at Pine Coulee, a saddle dyke at the northeast of the main dam, a diversion weir on Willow Creek, a diversion canal complete with headgates and reservoir inlet, a major causeway at the coulee crossing of Highway 527 and a minor causeway at the coulee crossing of E.W. section road, along the north boundary of Tp. 14.

3) Reservoir Capacity and Area

At FSL 1052.5 m (3,453 ft), the reservoir provides a storage capacity of 50.3 x 10^6 m^3 (40,745 ac ft) and a flooded area of 6 km^2 (2.32 sq mi) (see Drawing Nos. 1, 2, 3, 4, & 5).

4) Design Floods

The reservoir is classified as large in size and significant in risk, according to the 1983 Dams and Canals Safety guidelines. The project flood selected for the embankment dam is 0.75 PMF. The estimated PMF at the dam site is 209 m^3/s in peak discharge and 532 m^3/s-days in volume. The construction flood selected for the embankment dam is of 1:25 yr frequency which is estimated at 5.9 m^3/s in peak discharge and 26.08 m^3/s-days in volume.

The diversion weir is classified as small in size and significant in risk. The selected project flood is 0.3 PMF. The PMF estimate at the weir site is 1630 m^3/s in peak discharge and 4900 m^3/s - days in total volume. The construction flood selected for the diversion weir is the 1:25 yr flood, 159 m^3/s in peak discharge and 593.8 m^3/s-days in volume.

5) Upstream Slope Protection of Embankment Dam

The upstream slope of the main dam is subjected to waves and wave run-up generated by wind action. The 1 in 100 yr maximum hourly wind is used to establish the required size and thickness of the riprap material and bedding, and the wave surcharge.

6) Embankment Dam Freeboard

The crest elevation of the main dam and the saddle dyke is established by either the wave surcharge allowance or the project flood event, whichever is greater. In routing the project flood through the reservoir, the initial reservoir level is assumed at El. 1052.5 m with a concurrent hourly wind speed of once in 100 years. At this stage of design, the wave surcharge allowance is selected as dam freeboard, which is estimated at 1.9 m above the reservoir FSL.

7) Embankment Dam

The main dam is tentatively established with a 12 m wide crest at El. 1054.5 m. Both upstream and downstream slopes are 4:1 from the crest to a 50 m wide berm at El. 1043.3 m, and 8:1 from the berm to the valley floor. The dam crest is gravel lined and serves as relocated road (see Drawing No. 6).

8) Saddle Dyke

The saddle dyke has the same crest width and crest elevation as the main dam. Its crest is gravel lined for relocated road purposes. Side slopes of the saddle dyke are limited to 2.5:1 except at the higher fill at the northern reach where flatter slopes are required. Riprap protection is provided on the dyke slope facing the reservoir (see Drawing No. 2).

9) Causeways

The Highway 527 coulee crossing is raised to at least 1.7 m above the reservoir FSL. The existing SPCSP culvert will be extended to match the side slopes and provided with headwalls and granular protection to accommodate the two-way flow.

The E-W section road coulee crossing is raised to at least 1.4 m above the reservoir FSL. The existing culvert will be replaced with a gated CSP control structure to maintain a minimum flooded level at the upstream. Both causeways will be subgraded and paved to meet the existing conditions (see Drawing Nos. 13 & 14).

10) Diversion Weir

The weir consists of a permanent overflow section, a dyke and an emergency overflow section. The permanent overflow section is sized to pass the project flood and to divert a design discharge of 17 m^3/s (600 cfs) to the reservoir. A gated section, 5.0 m

wide, will permit to lower the creek level and to pass the flow when diversion is not needed. Built-in space for fish passage is also provided. The emergency overflow section provides safety in case of flood events larger than the project flood (see Drawing No. 9).

11) Diversion Canal

The main monthly flow during spring runoff at the diverson site is about 300 cfs. Willow Creek is subjected to high peak flows which occur during short period. The diversion canal should be able to carry a flow higher than the mean monthly flow otherwise the reservoir will not be filled during an average year. At high level, the reservoir will create backwater in the canal, which results in a varied flow condition. The canal is best designed by the modified regime approach which requires a 7 m bed width, 3:1 side slopes and 0.00018 bed grade. The canal will carry a dominant flow of 300 cfs, a design flow of more than 500 cfs and a bank full flow of 1200 cfs. Headgates will protect the canal works from Willow Creek floods and a reservoir inlet structure of baffle apron type is required for safe discharge under a wide range of tailwater conditions in the reservoir (see Drawing Nos. 2, 10, 11 & 12).

12) Outlet Works

A low level outlet works is provided at the embankment dam to permit the diversion of flow during the construction, the regulation of the stored water and the release of flood flow originated from the Pine Coulee creek. Sizing of the conduit is governed by construction practicality and easy access for inspection and maintenance. Access shaft is of wet well type, provided with safety ladder and air vent. The gate type and size are commercial product and readily available (see Drawing Nos. 7 & 8).

13) River Diversion During the Construction

The design construction flood at the embankment dam site is estimated at 5.9 m^3/s in peak discharge which could be easily handled by the low level outlet works. At the diversion weir site, the concrete overflow section and the dyke are constructed first on high ground. Closure of the creek bed will be done while diverting the creek flow through the completed gated opening of the overflow section.

14) Cost Estimates

The total project cost is estimated at $27,500,000, consisting of site services cost, construction cost, road relocation, reservoir and land costs, including a contingency provision of 20% to reflect the conceptual design stage (see Cost Summary).

15) Lower FSL Option

A lower FSL at elevation 1047.5 m is investigated. This option requires a minor saddle dyke at the reservoir rim, few additional works at the Highway 527 Willow Creek bridge and a shorter diversion canal. The storage capacity is however reduced in half to about 20,000 ac ft. Costing of this option is not available.

16) Pump-in Option

The pump-in option consists of a retention sheet piling rock weir at the PFRA proposed dam site on the Willow Creek, a pump station, discharge pipes, outflow structure, conveyance canal and reservoir inlet structure. Construction cost is estimated at $8,000,000. Details of cost summary are as attached. Since the Willow Creek high flows are of short duration, the pump-in option is not recommended.

17) Buried Conduit vs. Open Diversion Canal Option

The buried conduit could be either cast-in-place or precast. The cost is more than twice the open canal cost. This option is not pursued further.

18) Pine Coulee On-stream Site Option

As reported separately, a site on the Willow Creek immediately downstream of the Pine Coulee junction will provide an option capable of storing all run-off available at this site, in an average year.

ATTACHMENT

I - Pertinent Data

II - Cost Summary

III - Proposed Unit Costs

IV - Cost Item

V - Drawings

VI - Purp in Option

PERTINENT DATA

1) Reservoir

Project Flood	0.75 PMF	
FSL	1052.5 m	(3,453 ft)
Storage at FSL	$50.3 \times 10^6 m^3$	(40,745 ac ft)
Reservoir Area at FSL	$6.0 km^2$	(2.32 sq. mi.)
Freeboard or Surcharge	1.9 m	(6.3 ft)

2) Embankment Dam
(see Drawing No. 6)

Crest Elevation	1054.5 m	(3,459.6 ft)
Crest Length	450 m	(1,476 ft)
Maximum Height	21.2 m	(70 ft)
Composite Side Slopes	4:1 & 8:1	

Volume of Fill	$985,600 m^3$
Upstream Protection	$20,400 m^3$ of Riprap

3) Diversion Weir
(see Drawing No. 9)

Projected Flood	0.3 PMF	
Overall Length	605 m	(1985 ft)
Overflow Section		
Width	42 m	(138 ft)
Length	47.50 m	(156 ft)
Drop	9.75 m	(32 ft)
Gated Section		
Width	5.00 m	(16.40 ft)
Gate Type & Size	Radial Type 5,000 x 4,000 mm	
Fish Passage		
Type	Denil	
Width	2.25 m	
Gate Type & Size	Sluice Gate 36" x 96"	
Dyke Crest Elevation	1056.5 m	
Crest Width	4.5 m	
Side Slopes	2:1 U/S - 3:1 D/S	
Emergency Overflow		
Width	100 m	(328 ft)

4) Low Level Outlet
(see Drawing No. 7)

Intake Elevation	1035 m	
Conduit Size		
- Upstream	1.5 X 2.5 m	
- Downstream	1.5 x 2.13 m	
Gate	60" x 84" Sluice Gate	
Gate Well	Wet Type	

5) Diversion Canal
(see Drawing Nos. 2 & 11)

Length	3,500 m	(11,480 ft)
Bottom Width	7.0 m	(23 ft)
S/S	3:1	
Bed Grade	0.00018	
Depth to Banks	2.75 m	(9 ft)

6) Head Gates
(see Drawing No. 10)

7) Reservoir Inlet
(see Drawing No. 12)

8) Saddle Dyke
(see Drawing No. 2)

9) Highway 527 Causeway
(see Drawing No. 13)

10) E-W Road Causeway
(see Drawing No. 14)

PINE COULEE RESERVOIR

SITE 2

COST SUMMARY

A)	Site Services		$ 1,000,000
B)	Diversion Weir		$ 3,400,000
C)	Headgates		$ 250,000
D)	Diversion Canal		$ 2,400,000
E)	Reservoir Inlet		$ 320,000
F)	Embankment Dam		$ 7,500.000
G)	Outlet Works		$ 1,500,000
H)	Saddle Dyke		$ 2,500,000
I)	Causeway @ 527		$ 4,500,000
J)	Causeway @ E-W Road		$ 700,000
K)	Road Relocation		$ 700,000
L)	Reservoir & Lands		$ 2,700,000
	Total Project:		$ 27,470,000
		Say	$ 27,500,000

Proposed Unit Costs

A) **Site Services Cost**

1)	Performance Bond	0.4% of Contract Cost
2)	Labour & Material Bond	0.2% of Contract Cost
3)	Construction Road	$ 25,000/km
4)	Powerline	$ 20,000/km

Damages & Mitigations Cost

1)	Reservoir Cleaning	$ 1,000/Ha
2)	Road Location:	
	- Trail Upgraded	$ 40,000/km
	- New Location	$ 60,000/km
3)	Cultivated Dry Land	$ 1,000/ac
4)	Range Pasture	$ 500/ac
5)	Valley Walls	$ 300/ac
6)	Large Farmstead	$400,000/farm
7)	Medium Farmstead	$200,000/farm
8)	Small Farmstead	$ 50,000/farm

Contingencies

1)	Conceptual Estimates	20%
2)	Level I Estimates	15%
3)	Level II Estimates	10%

Engineering Fees/Cost

1)	Up to Contract Stage	10-15% of Contract Cost
2)	Turnkey	20% of Contract Cost

B) Construction Cost

1)	Stripping	$ 1.6/m^3
2)	Common Excavation	$ 1.6/m^3
3)	Structural Excavation	$ 3.0/m^3
4)	Compacted Impervious Fill	$ 1.00/m^3
5)	Tamped Impervious Backfill	$ 5.00/m^3
6)	Drain & Blanket	$ 20.0/m^3
7)	Gravel Protection, Liner	$ 10.0/m^3
8)	Road Gravel	$ 10.0/m^3
9)	Pitrun Gravel	$ 8.0/m^3
10)	Riprap	$ 50.0/m^3
11)	Coarse Filter	$ 15.0/m^3
12)	Fine Filter	$ 18.0/m^3
13)	Topsoil & Seeding	$ 7,000/Ha
14)	Steel Sheet Piling	$ 200/m^2
15)	Fencing	$ 3.0/m
16)	Lean Concrete	$ 200/m^3
17)	Reinforced Concrete (included re-bars)	
	- Spillway, Weir, Outlet Works	$ 350/m^3
	- Other Structures	$ 400/m^3

COST ITEM

A) **Site Services**

1)	Performance Bond	L.S.	$ 80,000
2)	Labour & Materials Bond	L.S.	$ 40,000
3)	Construction Camp & Office	L.S.	$ 200,000
4)	Construction Roads	5 km @ $25,000	$ 125,000
5)	Powerlines	10 km @ $20,000	$ 200,000
6)	Utilities	L.S.	$ 50,000
7)	Surface Drainage	L.S.	$ 50,000
8)	Landscaping	L.S.	$ 50,000
9)	Miscellaneous		$ 50,000
			$ 845,000
		x 1.2 =	$ 1,014,000
		Say	$ 1,000,000

B) Diversion Weir

1)	Mobilization & Demobilization	L.S.	$ 100,000
2)	Care of Water	L.S.	$ 150,000
3)	Common Excavation	228,000 m^3 @ $1.6	$ 364,800
4)	Structural Excavation	1,000 m^3 @ $3.0	$ 3,000
5)	Compacted Impervious Fill	58,000 m^3 @ $1.00	$ 58,000
6)	Tamped Impervious Backfill	3,500 m^3 @ $5.00	$ 17,500
7)	Riprap	3,400 m^3 @ $50.00	$ 170,000
8)	Coarse Filter	2,300 m^3 @ $15.00	$ 34,500
9)	Fine Filter	1,100 m^3 @ $18.00	$ 19,800
10)	Drain Gravel	4,400 m^3 @ $20.00	$ 88,000
11)	Topsoil & Seeding	4.7 Ha @ $700	$ 3,290
12)	Sheet Piling	500 m^2 @ 200.0	$ 100,000
13)	Lean Concrete	140 m^3 @ 200.0	$ 28,000
14)	Reinforced Concrete	4,100 m^3 @ $350.0	$1,435,000
15)	Gate & Hoist, 5000 x 4000 mm Radial Gate	1 Unit @ $100,000	$ 100,000
16)	Fish Pass	L.S.	$ 50,000
17)	Miscellaneous		$ 100,000
			$2,821,890
		x 1.2	$3,386,268
		Say	$3,400,000

C) Headgates

1)	Structural Excavation	300 m^3 @ $3.0	$ 900
2)	Tamped Impervious Backfill	1300 m^3 @ $5.00	$ 6,500
3)	Riprap	700 m^3 @ 50.0	$ 35,000
4)	Coarse Filter	400 m^3 @ $15.00	$ 6,000
5)	Fine Filter	200 m^3 @ $18.00	$ 3,600
6)	Road Gravel	10 m^3 @ $10.0	$ 100
7)	Lean Concrete	10 m^3 @ $200.0	$ 2,000
8)	Reinforced Concrete	250 m^3 @ $400.0	$100,000
9)	Gates & Hoists, 72" x 96" Sluice Gate	3 Units @ $10,000	$ 30,000
10)	Miscellaneous		$ 25,000
			$209,100
		x 1.2 =	$250,920
		Say	$250,000

D) Diversion Canal

1)	Stripping	14,500 m^3 @ $1.60	$ 23,200
2)	Common Excavation	776,000 m^3 @ $1.60	$1,241,600
3)	Compacted Impervious Fill	82,000 m^3 @ 1.00	$ 82,000
4)	Gravel Liner	~~27,000 m^3~~ @ $10.00	$ 270,000
5)	Road Gravel	1,600 m^3 @ $10.00	$ 16,000
6)	Topsoil & Seeding	3.50 Ha @ $7,000	$ 24,500
7)	Cross Drainage	2 Units @ $50,000	$ 100,000
8)	Bridge	200 m^2 @ $1,000	$ 200,000
9)	Fencing		$ 20,000
10)	Miscellaneous		$ 30,000
			$2,007,300
		x 1.2 =	$2,408,760
		Say	$2,400,000

E) Reservoir Inlet

1)	Structural Excavation	7,200 m^3 @ $3.0	$ 21,600
2)	Tamped Impervious Fill	2,100 m^3 @ $5.0	$ 10,500
3)	Rirpap	100 m^3 @ $50.0	$ 10,000
4)	Coarse Filter	200 m^3 @ $15.00	$ 3,000
5)	Fine Filter	150 m^3 @ $18.00	$ 2,700
6)	Lean Concrete	65 m^3 @ $200	$ 13,000
7)	Reinforced Concrete	450 m^3 @ $400	$180,000
8)	Miscellaneous		$ 25,000
			$265,800
		x 1.2 =	$318,960
		Say	$320,000

F) Embankment Dam

1)	Mobilization & Demobilization	L.S.	$ 400,000
2)	Care of Water	L.S.	$ 50,000
3)	Common Excavation	65,000 m^3 @ $1.60	$ 104,960
4)	Compacted Impervious Fill	985,600 m^3 @$1.00	$ 985,600
5)	Coarse Filter	98,400 m^3 @ $15.00	$1,476,000
6)	Fine Filter	91,600 m^3 @ $18.00	$1,648,800
7)	Pitrun Gravel	7,800 m^3 @ $8.00	$ 62,400
8)	Riprap	20,400 m^3 @ $50.00	$1,020,000
9)	Road Gravel	550 m^3 @ $10.00	$ 5,500
10)	Topsoil & Seeding	6.4 Ha @ $700.00	$ 4,480
11)	Wick Drain	L.S.	$ 232,000
12)	Instrumentation	L.S.	$ 35,000
13)	Road Guardrail	L.S.	$ 50,000
14)	Miscellaneous		$ 100,000
			$6,174,740
		x 1.2	$7,409,688
		Say	$7,500,000

G) Outlet Works

1)	Common Excavation	60,000 m^3 @ $1.6	$ 96,000
2)	Structural Excavation	10,000 m^3 @ $3.0	$ 30,000
3)	Tamped Impervious Backfill	10,000 m^3 @ $5.00	$ 50,000
4)	Riprap	200 m^3 @ $50.00	$ 10,000
5)	Coarse Filter	200 m^3 @ $15.00	$ 3,000
6)	Fine Filter	150 m^3 @ $18.00	$ 2,700
7)	Lean Concrete	45 m^3 @ $200.0	$ 9,000
8)	Reinforced Concrete	2,000 m^3 @ $350	$ 700,000
9)	Bituminous Paint	L.S.	$ 30,000
10)	Gate & Lift - 60" x 84" Sluice Gate	1 Unit @ $50,000	$ 50,000
11)	Air Vent	L.S.	$ 20,000
12)	Safety Ladder	L.S.	$ 60,000
13)	Metal Building	L.S.	$ 100,000
14)	Miscellaneous		$ 50,000
			$1,210,700
		x 1.2 =	$1,452,840
		Say	$1,500,000

H) Saddle Dyke

1)	Stripping	50,000 m^3 @ $1.60	$ 80,000
2)	Compacted Impervious Fill	400,000 m^3 @ $1.00	$ 400,000
3)	Drain & Blanket	27,000 m^3 @ $10.0	$ 270,000
4)	Riprap	22,700 m^3 @ $50.00	$1,135,000
5)	Pitrun Gravel	6,500 m^3 @ $8.00	$ 52,000
6)	Road Gravel	3,400 m^3 @ $10.0	$ 34,000
7)	Topsoil & Seeding	3.5 Ha @ $7,000	$ 24,500
8)	Road Guardrail	L.S.	$ 15,000
9)	Miscellaneous		$ 50,000
			$2,060,500
		x 1.2 =	$2,472,600
		Say	$2,500,000

I) Causeway @ 527

1)	Mobilization & Demobilization	L.S.	$ 100,000
2)	Traffic Detour & Control	L.S.	$ 50,000
3)	Common Excavation	334,000 m^3 @ $1.60	$ 534,400
4)	Compacted Impervious Fill	261,000 m^3 @ $1.00	$ 261,000
5)	Road Subgrade & Pavement	L.S.	$ 42,000
6)	Riprap	29,000 m^3 @ $50.00	$1,450,000
7)	Coarse Filter	38,300 m^3 @ $15.00	$ 574,500
8)	Fine Filter	26,800 m^3 @ $18.00	$ 482,400
9)	Wick Drain	L.S.	$ 100,000
10)	SPCSP Extended & Up-grades	L.S.	$ 50,000
11)	Road Guardrail	L.S.	$ 30,000
12)	Miscellaneous		$ 50,000
			$3,724,300
		x 1.2 =	$4,469,160
		Say	$4,500,000

J) Causeway @ EW Road - North Boundary Tp 14

1)	Traffic Detour & Control	L.S.	$ 20,000
2)	Common Excavation	37,500 m^3 @ $1.60	$ 60,000
3)	Compacted Impervious Fill	27,500 m^3 @ $1.00	$ 27,500
4)	Riprap	5,650 m^3 @ $50.0	$ 282,500
5)	Coarse Filter	2,850 m^3 @ $15.00	$ 42,750
6)	Fine Filter	1,700 m^3 @ $18.00	$ 30,600
7)	Road Sub-base & Pavement	L.S.	$ 30,000
8)	Gates CSP Structure	L.S.	$ 60,000
9)	Road Guardrail	L.S.	$ 20,000
10)	Miscellaneous		$ 20,000
			$ 593,350
		x 1.2 =	$ 712,020
		Say	$ 700,000

K) Road Relocation

1)	Traffic Detour & Control	L.S.	$ 50,000
2)	Upgraded Gravel Road	3.3. km @ $40,000	$ 132,000
3)	New Gravel Road	4.8 km @ $60,000	$ 288,000
4)	Fencing	9,600 m @ $3.0	$ 28,000
5)	Traffic Sign	L.S.	$ 10,000
6)	Miscellaneous		$ 50,000
			$ 558,800
		x 1.2 =	$ 670,560
		Say	$ 700,000

L) Reservoir & Lands

1)	Reservoir Clearing	600 Ha @ $1,000	$ 600,000
2)	Rim Stabilization	L.S.	$ 200,000
3)	Cultivated Dry Land	140 Ac @ $1,000	$ 140,000
4)	Range Pasture	700 Ac @ $500	$ 350,000
5)	Valley Walls	140 Ac @ $300	$ 42,000
6)	Large Farmstead	1 Unit @ $400,000	$ 400,000
7)	Medium Farmstead	1 Unit @ $200,000	$ 200,000
8)	Small Farmstead	3 Units @ $50,000	$ 150,000
9)	Wells	L.S.	$ 30,000
10)	Refencing	L.S.	$ 50,000
11)	Miscellaneous		$ 50,000
			$2,212,000
		x 1.2 =	$2,654,400
		Say	$2,700,000

Pump in Option

Cost Summary

Construction Costs	
Station	$ 2,000,000
Pumps & Motors (1)	$ 4,300,000
Weir	$ 900,000
Conveyance	$ 800,000
	$ 8,000,000

(1) Pump Capacity

3 Units @ 52,500 VSGPM

Total Capacity $10 m^3/s$

350 cfs

Pump Station

1)	Mobilization & Demobilization	L.S.	$ 200,000
2)	Care of Water	L.S.	$ 100,000
3)	Excavation	50,000 m^3 @ $3.0	$ 150,000
4)	Backfill	30,000 m^3 @ $2.0	$ 40,000
5)	H Piles	1,200 m @ $150	$ 180,000
6)	Reinforced Concrete	900 m^3 @ $350	$ 315,000
7)	Discharge Pipelines	210 m @ $1,500	$ 315,000
8)	Miscellaneous		$ 200,000
			$1,500,000
		x 1.3	$2,000,000
			$2,000,000

Pumps & Motors

1)	Pumps & Electric Motors USGPM 52500, Supply & Installation (Supply = 400,000) (Installation = 100,000)	3 Units @ $500,00	$1,500,000
2)	Valves & Control	L.S.	$ 500,000
3)	Internal Electrical Switch Gear	L.S.	$ 200,000
4)	Powerline & Sub-station	L.S.	$ 300,000
5)	Building & Hoist	L.S.	$ 300,000
6)	Miscellaneous		$ 500,000
			$3,300,000
		x 1.3	$4,300,000

Weir

1)	Care of Water	L.S.	$ 100,000
2)	Excavation	12,000 m^3 @ $3.0	$ 36,000
3)	Backfill	4,000 m^3 @ $2.0	$ 8,000
4)	Sheet Piling	700 m^2 @ $300	$ 210,000
5)	Riprap & Bedding	8,000 m^3 @ $20.0	$ 160,000
6)	Reinforced Concrete	280 m^3 @ $350	$ 98,000
7)	Miscellaneous		$ 100,000
			$ 712,000
		x 1.3 =	$ 900,000

Conveyance Channel

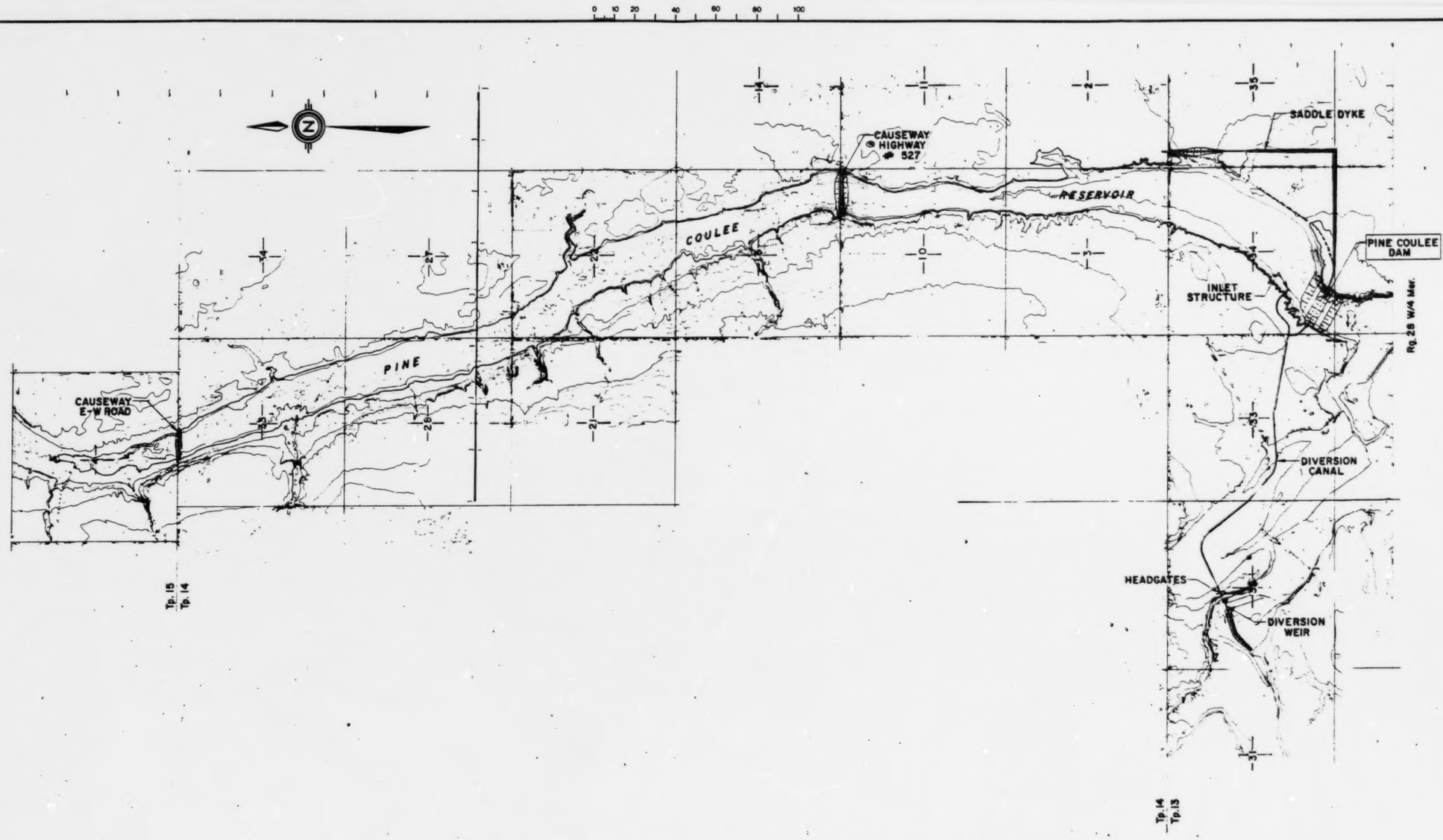
1)	Outflow Structure	L.S.	$ 100,000
2)	Excavation	65,000 m^3 @ $1.5	$ 97,500
3)	Gravel Liner	5,000 m^3 @ $10	$ 50,000
4)	Reservoir Inlet	Reported	$ 300,000
5)	Miscellaneous		$ 60,000
			$ 607,500
		x 1.3 =	$ 800,000

MICROFILM DATE

DRAWING FILE No.

CENTRAL FILE No.

0 10 20 40 60 80 100



MARK	NATURE OF REVISION	DATE	ENG.	DWN.
1				
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Alberta ENVIRONMENT — DESIGN AND CONSTRUCTION DIVISION

SUBMITTED ..... DESIGNED .....
DATE ..... CHECKED .....
APPROVED ..... DRAWN .....
DATE ..... CHECKED .....

WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

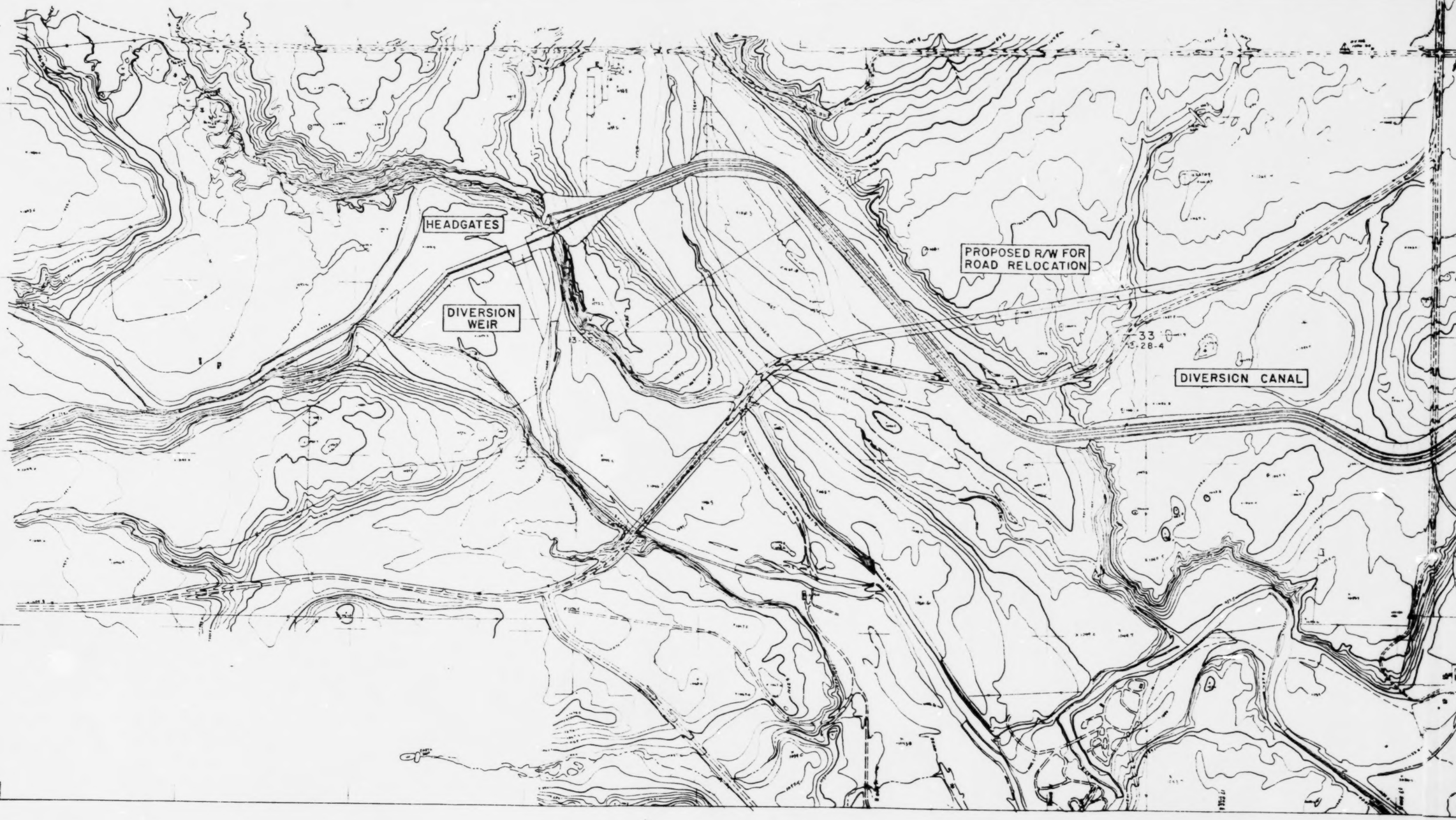
GENERAL PLAN

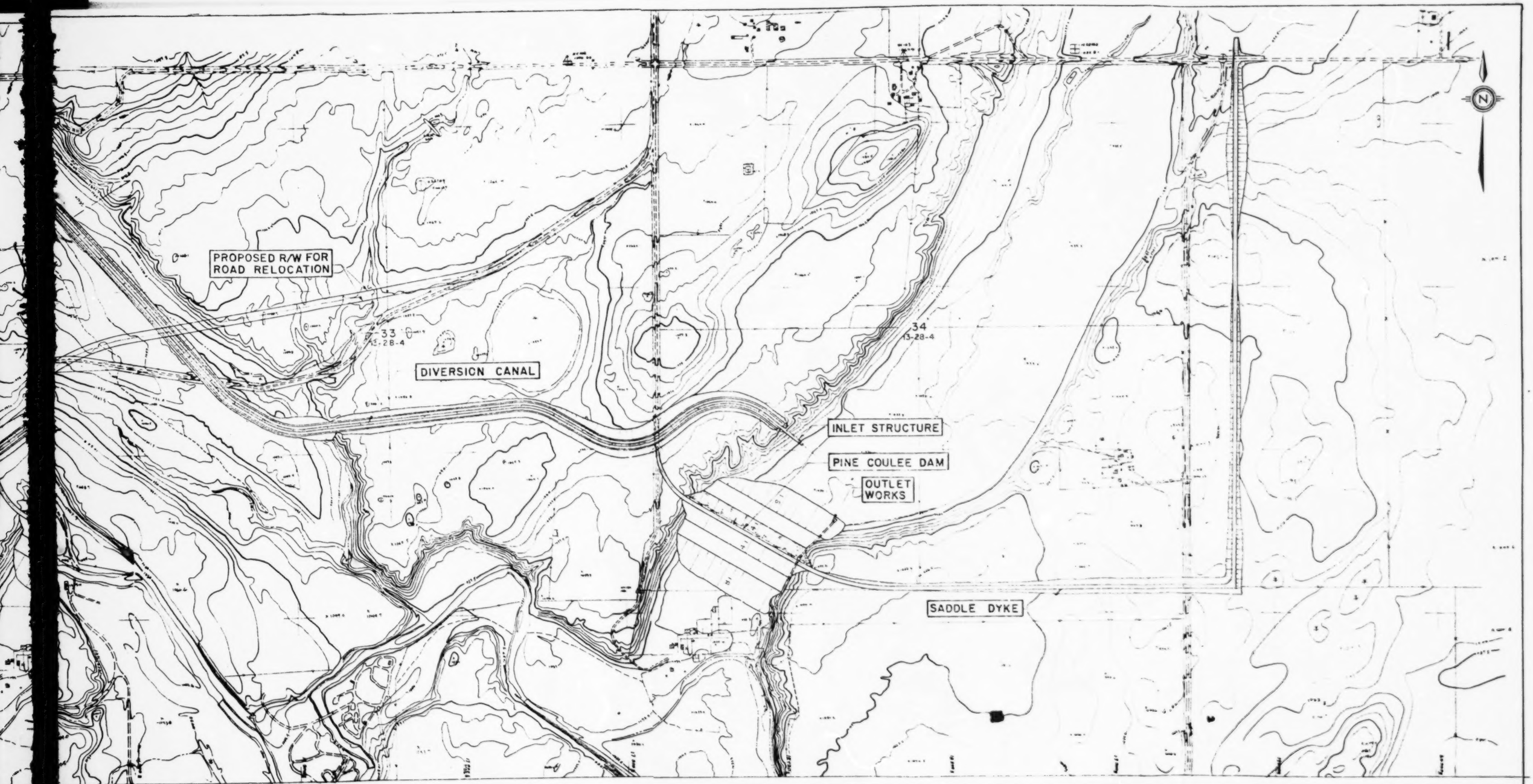
SCALE 1:20 000 — SHEET 1 OF
DATE AUGUST, 1985 — DWG. No.

P1-560x860

G F E D C B A

4 3 2 1


HEADGATES
DIVERSION WEIR
PROPOSED R/W FOR ROAD RELOCATION
33
13-28-4
DIVERSION CANAL



MARK	NATURE OF REVISION	DATE	ENG. DWN.
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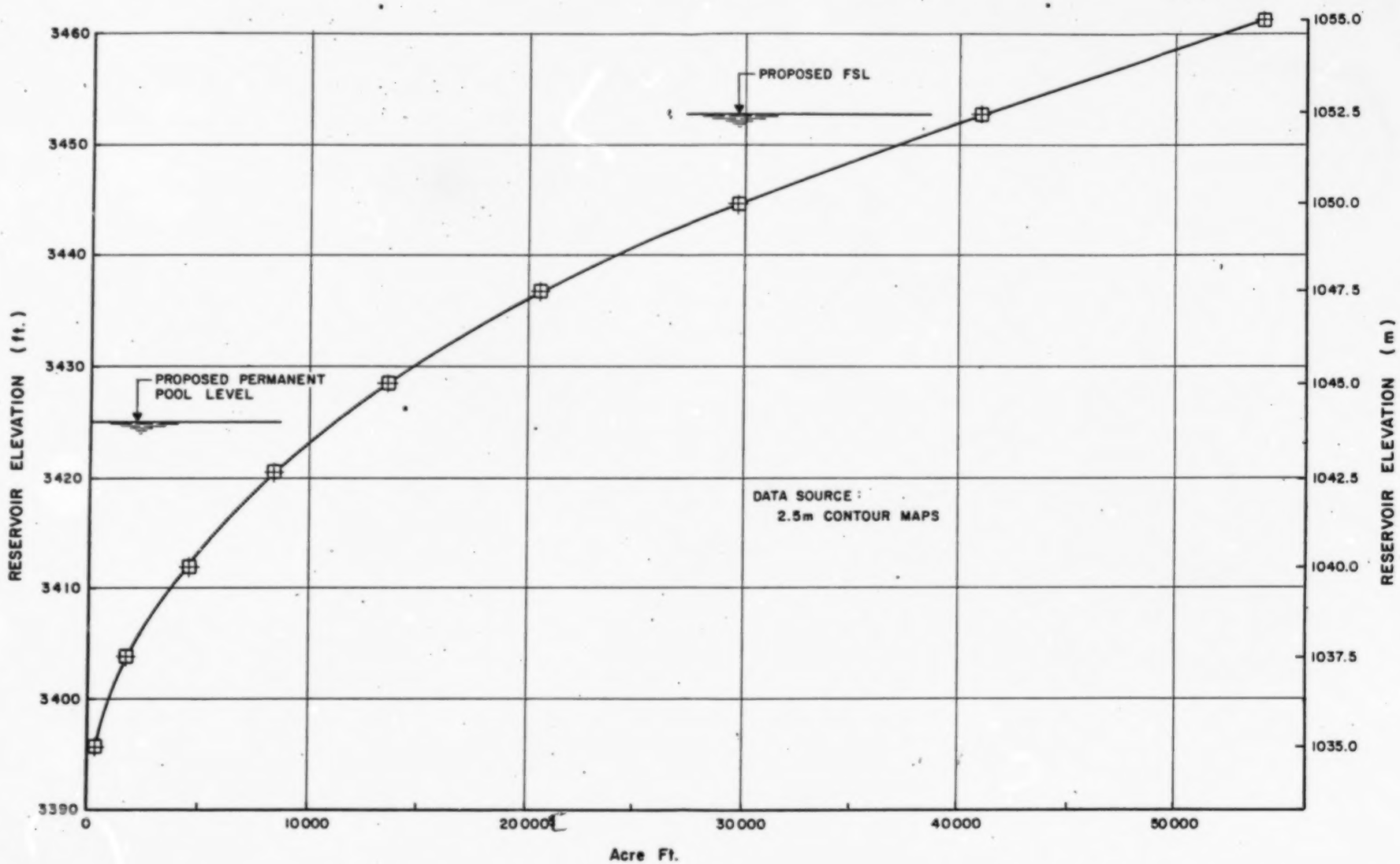
Alberta ENVIRONMENT — Design and Construction Division

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN
DATE	CHECKED

WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

SITE PLAN

SCALE 1 : 5000 — SHEET 2 OF
DATE AUGUST, 1985 — DRAWING No.



MICROFILM DATE

DRAWING FILE No.

CENTRAL FILE No.

P3-260×430

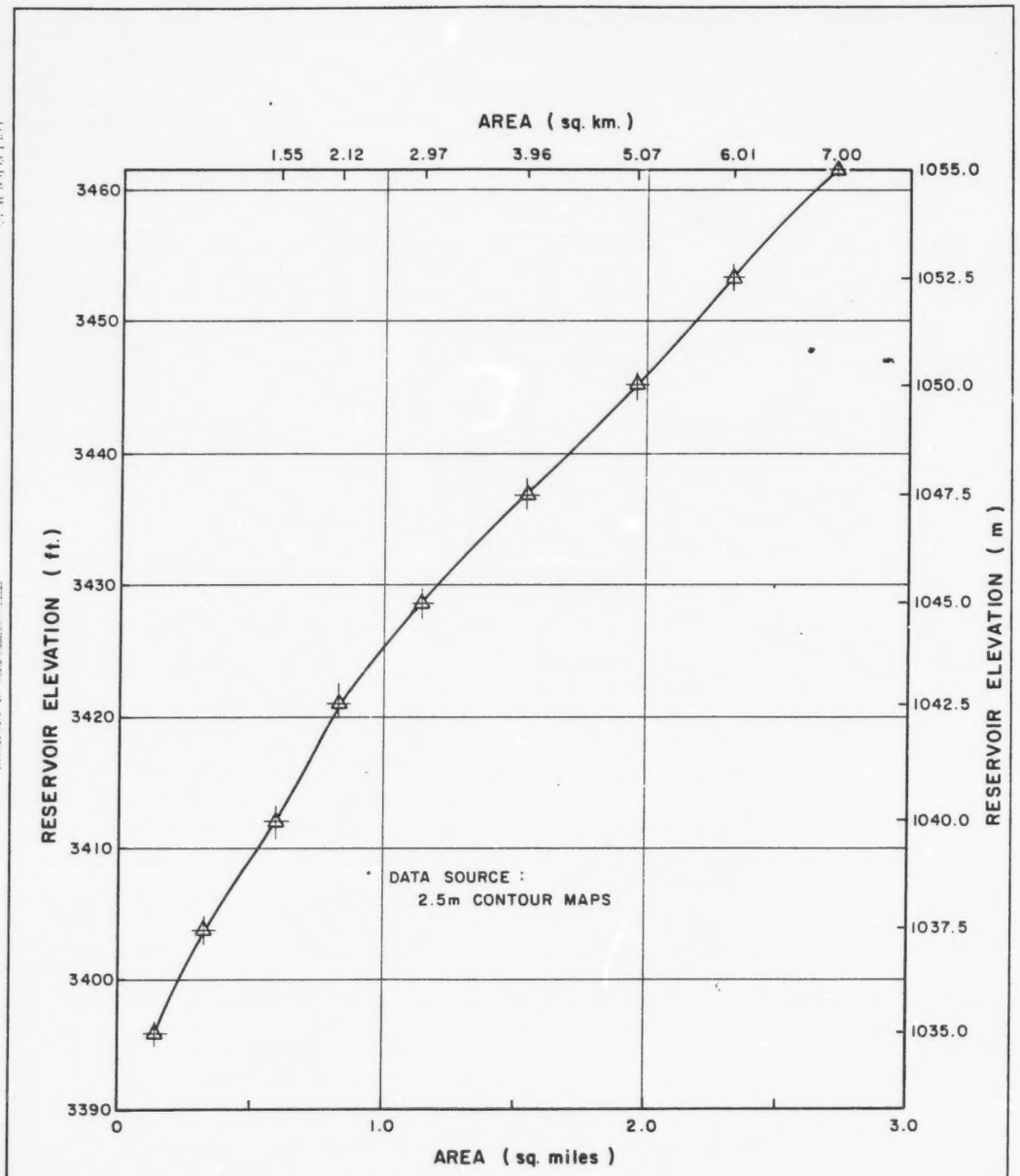
Alberta ENVIRONMENT — DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN B. Sanders
DATE	CHECKED

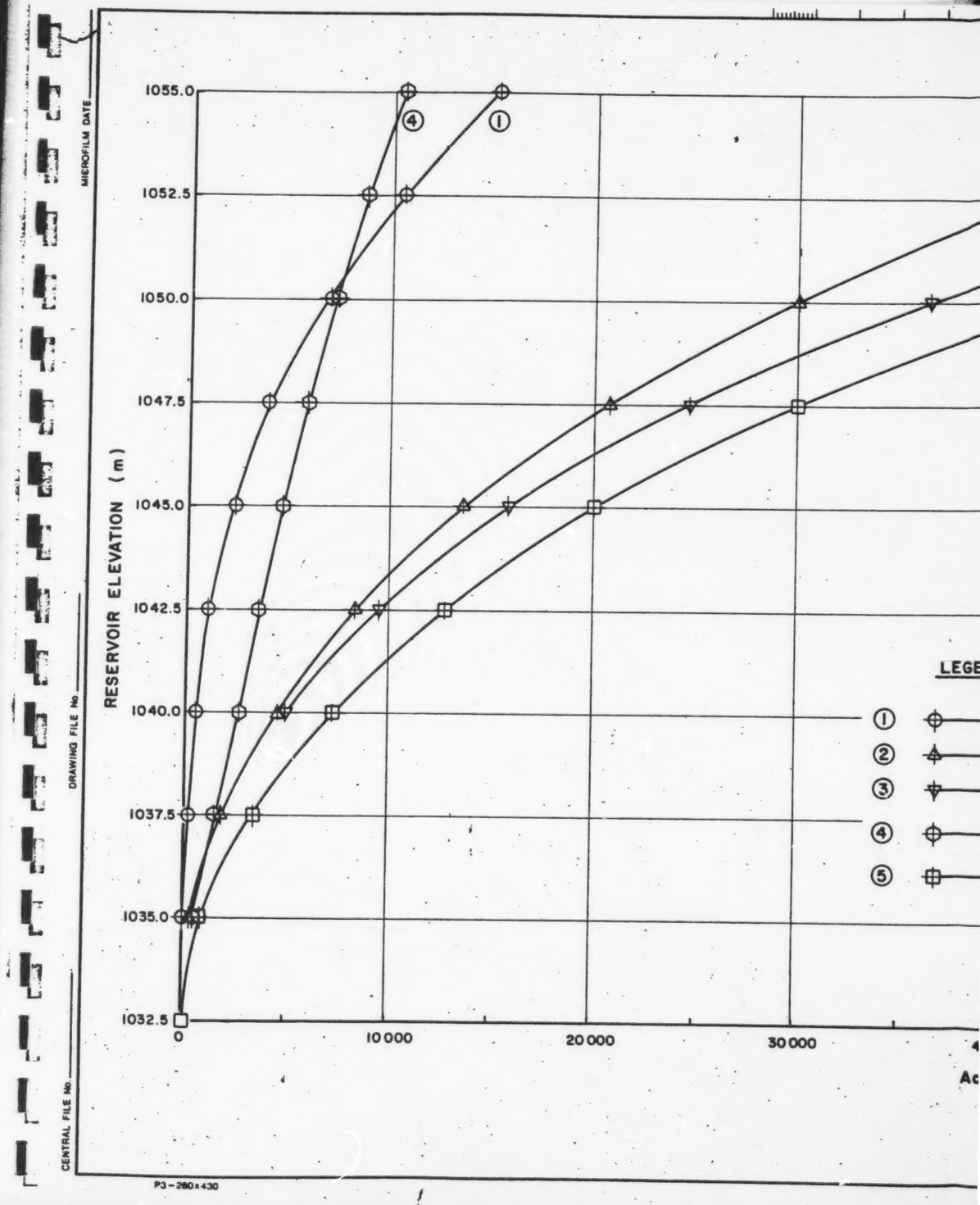
WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

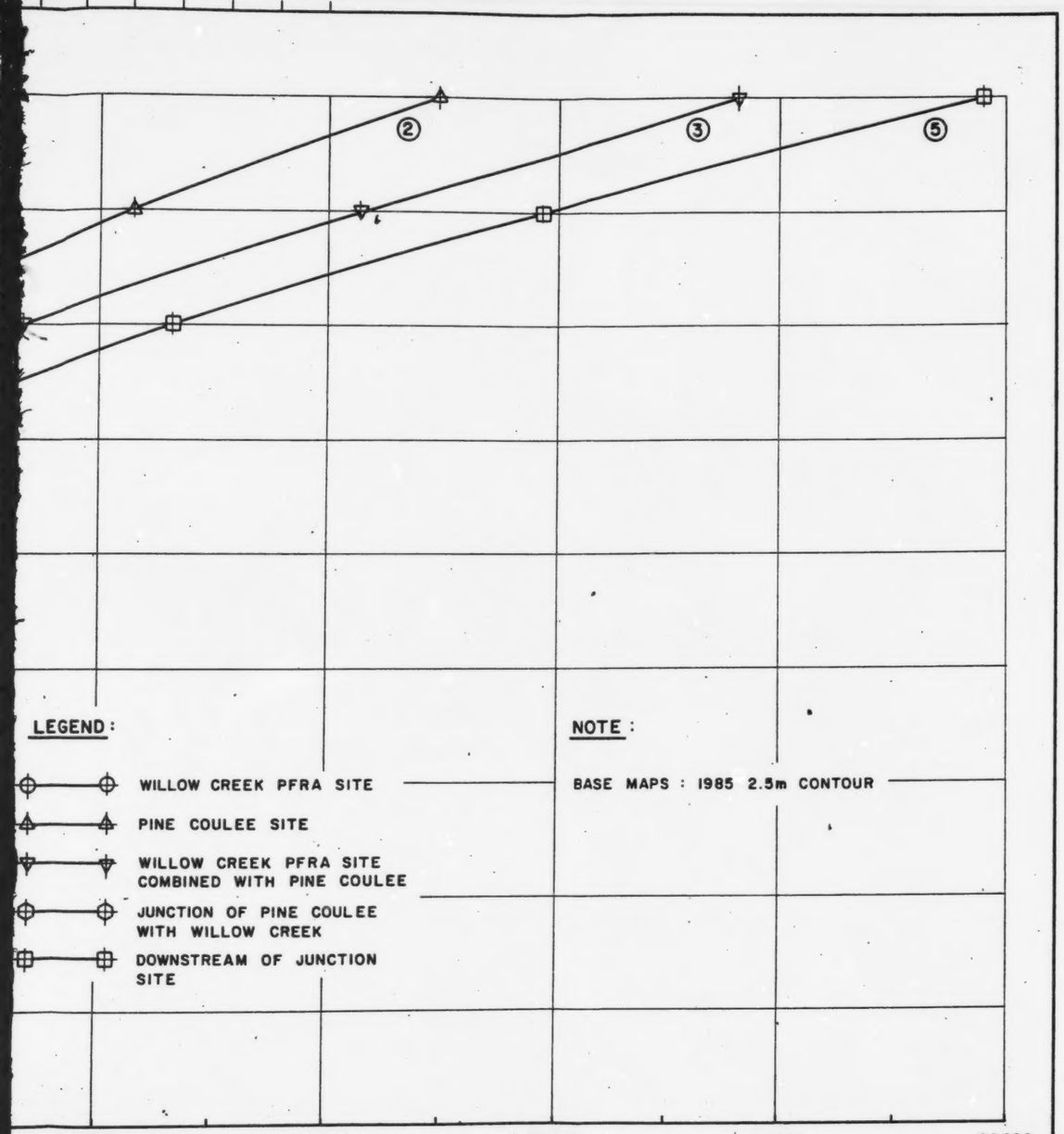
STORAGE CURVE

SCALE AS SHOWN — SHEET 3 OF
DATE AUG., 1988 — DRAWING No



Alberta ENVIRONMENT — DESIGN AND CONSTRUCTION DIVISION		WILLOW CREEK PROJECT PINE COULEE RESERVOIR
SUBMITTED DATE	DESIGNED CHECKED	AREA CURVE
APPROVED DATE	DRAWN B. Sanders CHECKED	SCALE: AS SHOWN SHEET 4 DATE AUG., 1985 DRAWING No.





LEGEND:

- WILLOW CREEK PFRA SITE
- PINE COULEE SITE
- WILLOW CREEK PFRA SITE COMBINED WITH PINE COULEE
- JUNCTION OF PINE COULEE WITH WILLOW CREEK
- DOWNSTREAM OF JUNCTION SITE

NOTE:

BASE MAPS : 1985 2.5m CONTOUR

40000 50000 60000 70000 80000

Acre Ft.

Alberta ENVIRONMENT DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN B. Sanders
DATE	CHECKED /

WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

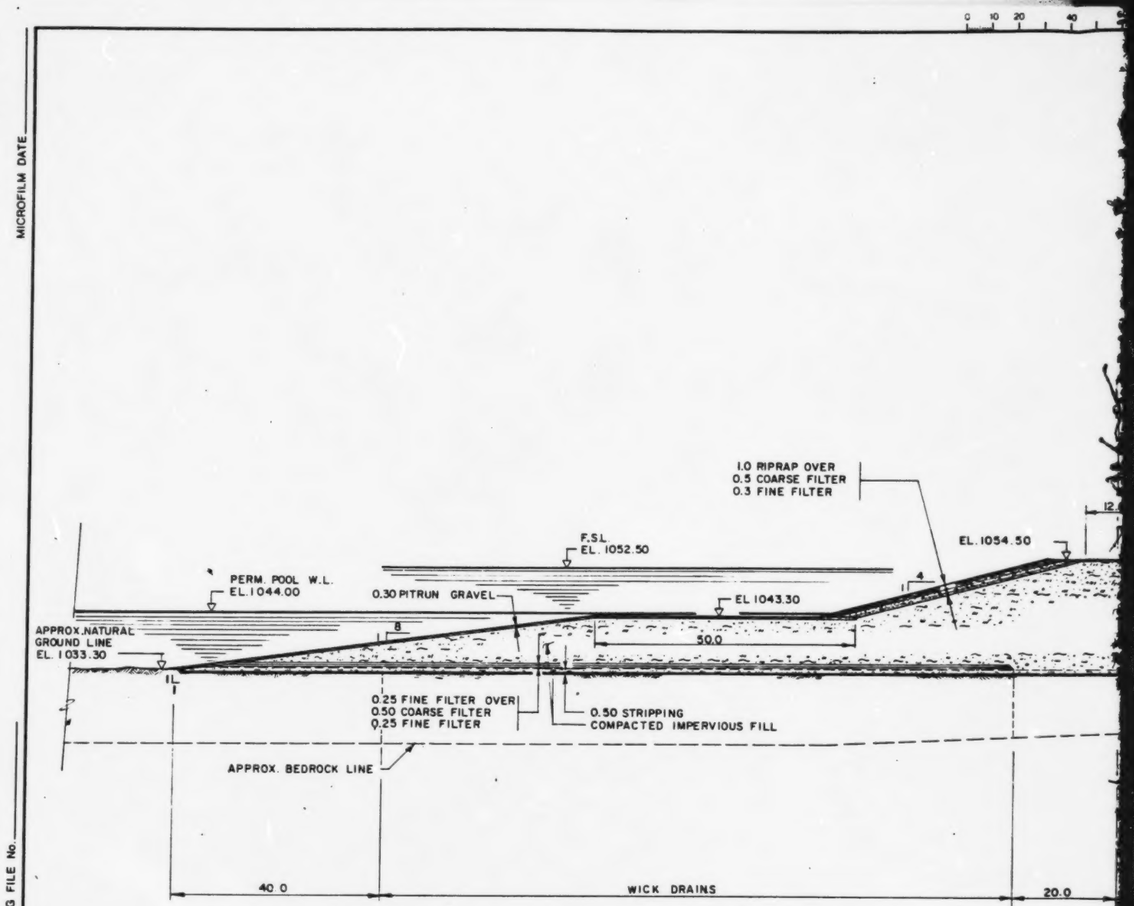
RESERVOIR CAPACITY CURVES

SCALE AS SHOWN | SHEET 5 OF
DATE AUG., 1985 | DRAWING No

MICROFILM DATE

DRAWING FILE No.

CENTRAL FILE No.



TYPICAL CROSS

MARK	NATURE OF REVISION
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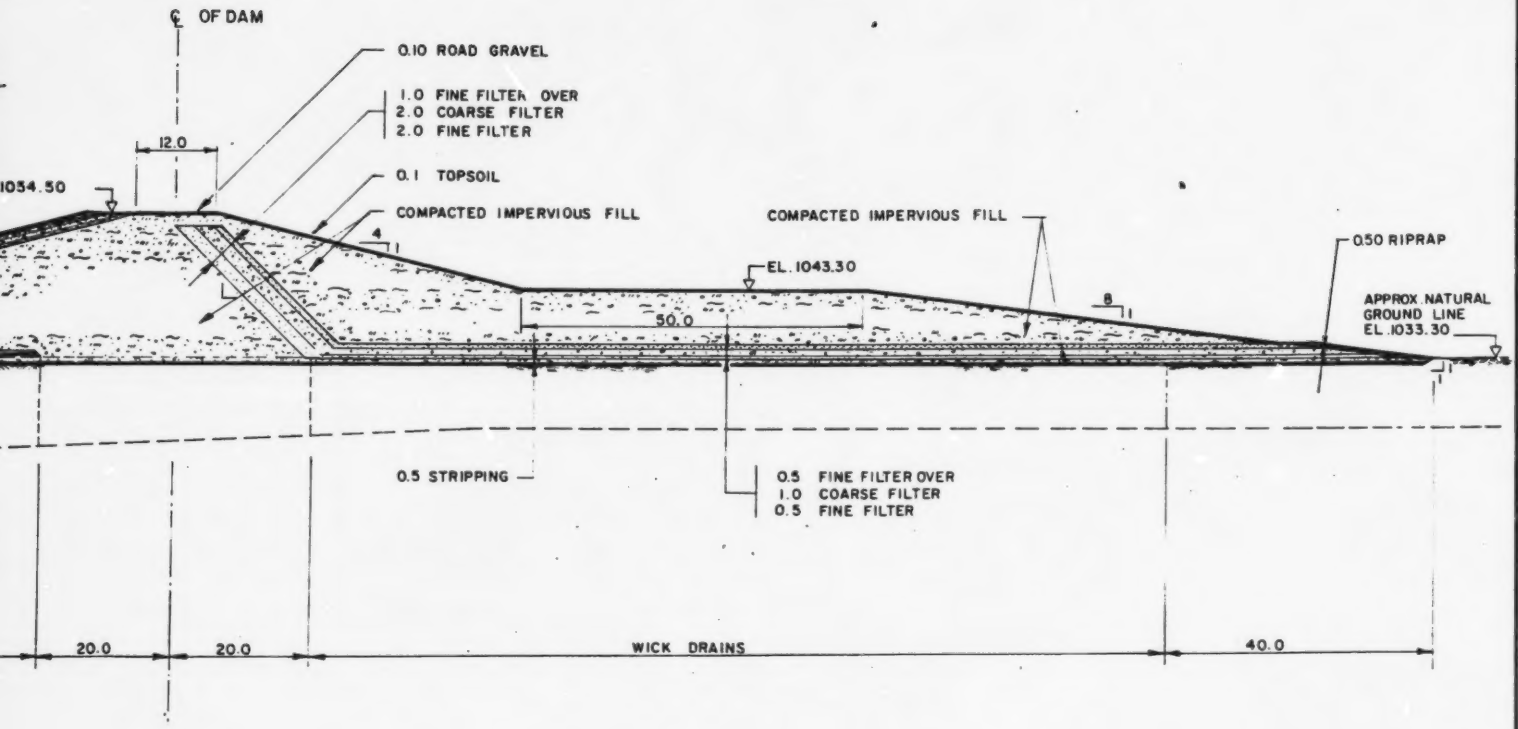
P1-560x860



CAL CROSS SECTION

NATURE OF REVISION	DATE	ENG.	DWN.

Alberta ENVIRONMENT — DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN F. Fejerdean
DATE	CHECKED

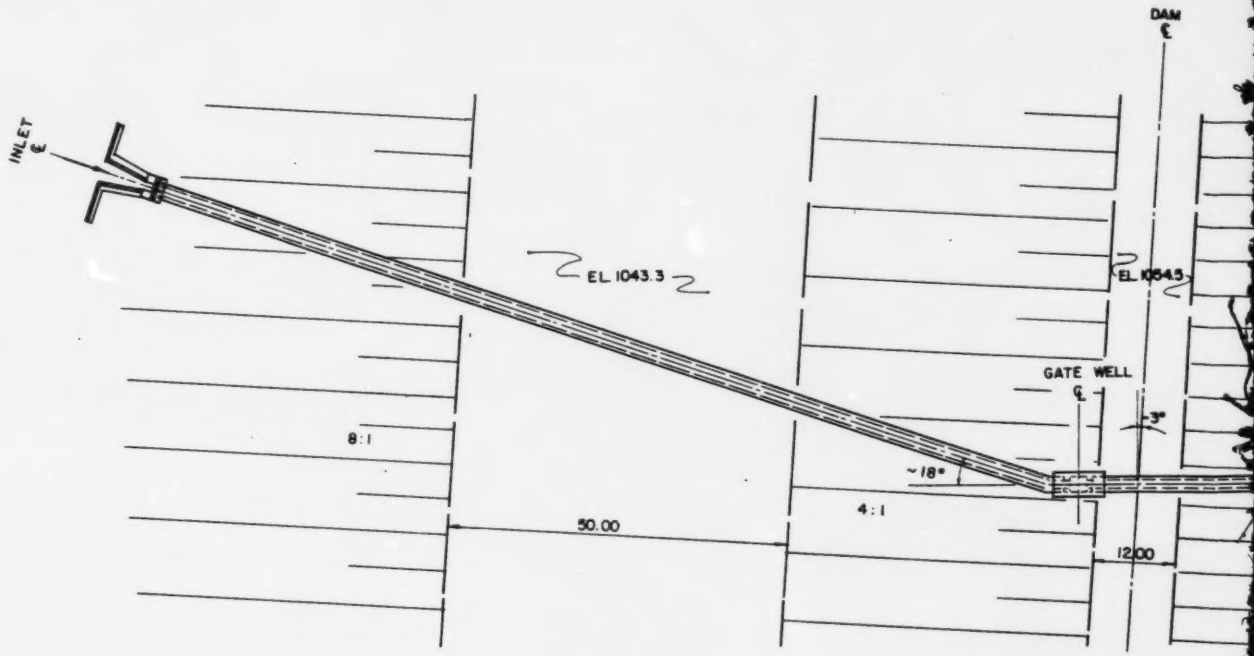
WILLOW CREEK PROJECT

PINE COULEE RESERVOIR

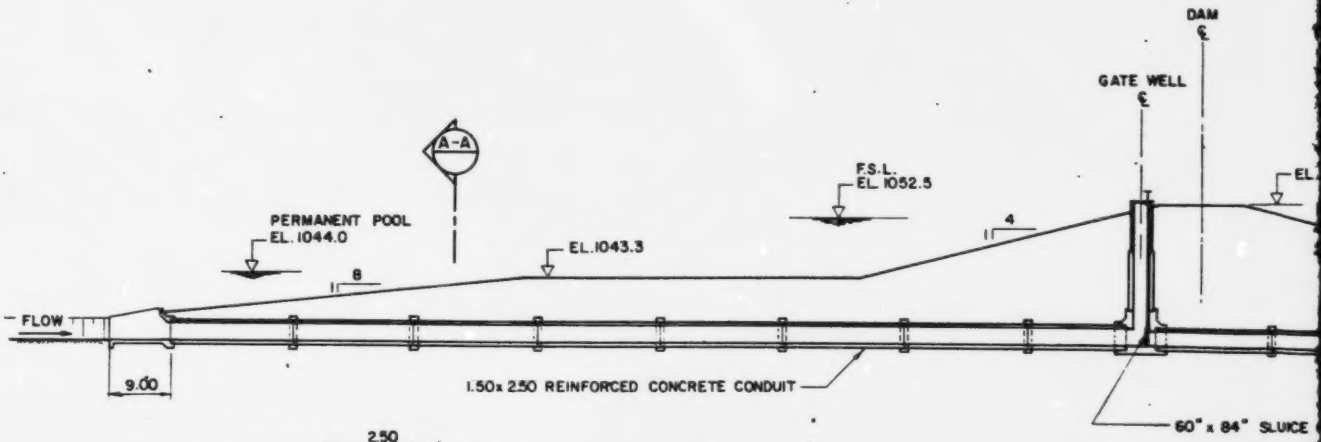
TYPICAL DAM EMBANKMENT CROSS SECTION

SCALE 1 : 500	SHEET 6 OF
DATE AUGUST, 1985	DWG. No

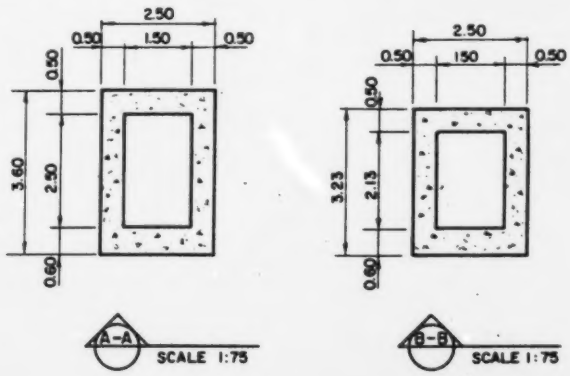
D C B A



PLAN
SCALE 1:500



CENTRE LINE SECTION
SCALE 1:500



A-A SCALE 1:75

B-B SCALE 1:75

MARK	NATURE OF REVISION
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MICROFILM DATE

DRAWING FILE No.

CENTRAL FILE No.

P1-560 x 860
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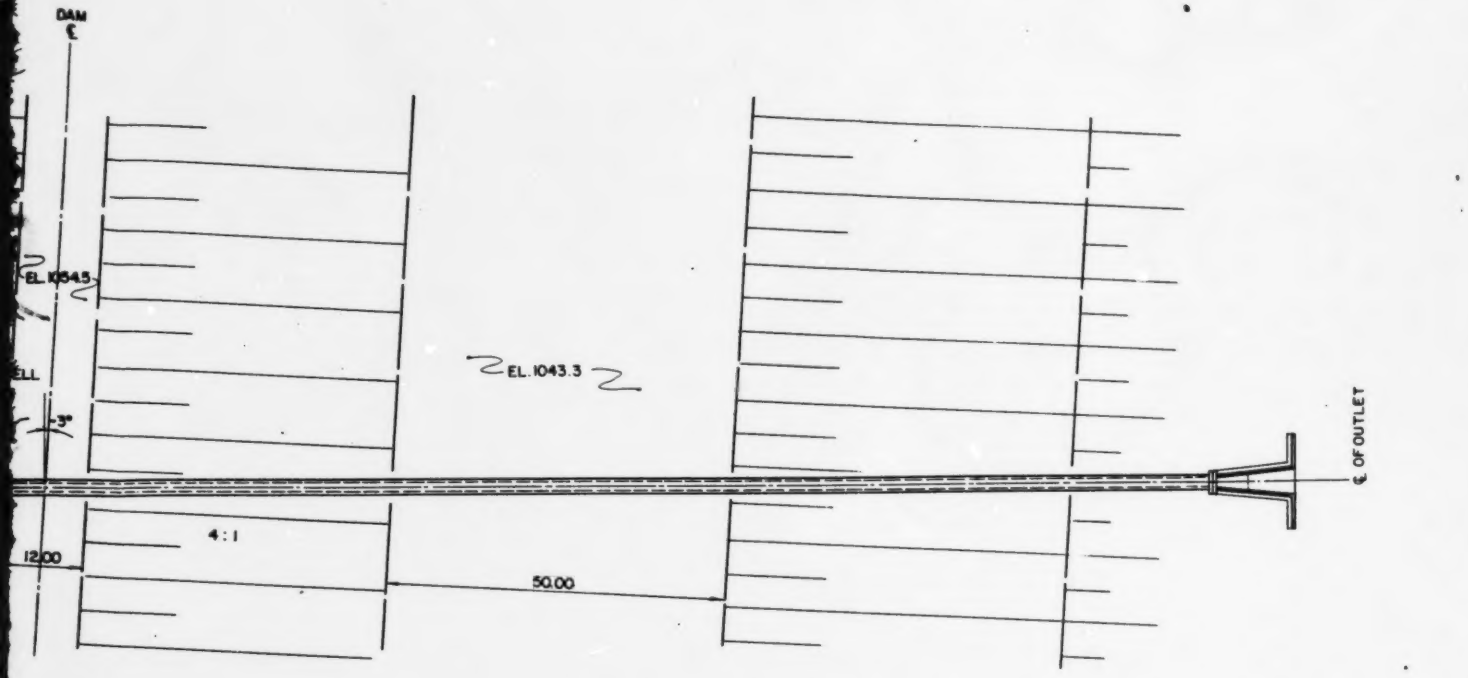
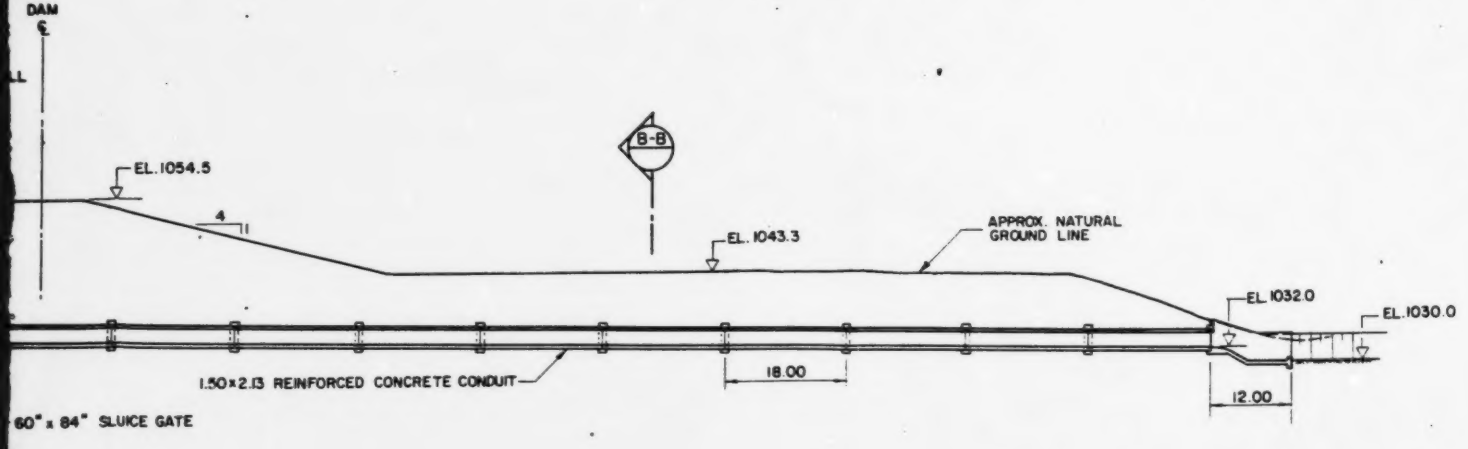


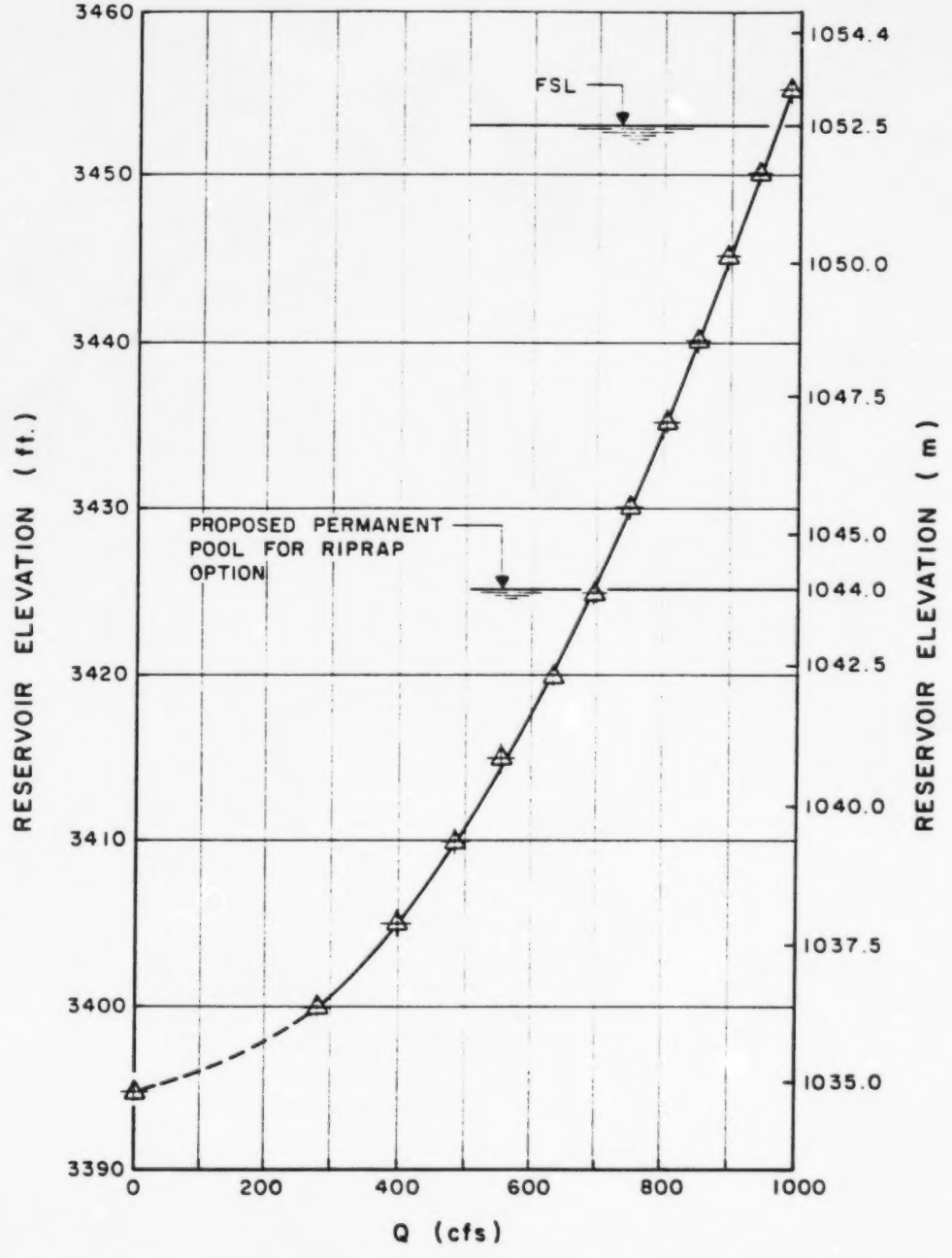
LAN
LE 1:500



SECTION
00

				Alberta ENVIRONMENT DESIGN AND CONSTRUCTION DIVISION	WILLOW CREEK PROJECT	
					PINE COULEE RESERVOIR	
				SUBMITTED ..... DESIGNED	OUTLET WORKS	
				DATE ..... CHECKED		
				APPROVED ..... DRAWN	SCALE AS SHOWN	SHEET 7 OF
NATURE OF REVISION	DATE	ENG.	DWN.	DATE ..... CHECKED	DATE AUGUST, 1985	DWG. No.

D C B A



Alberta ENVIRONMENT

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN B. Sanders
DATE	

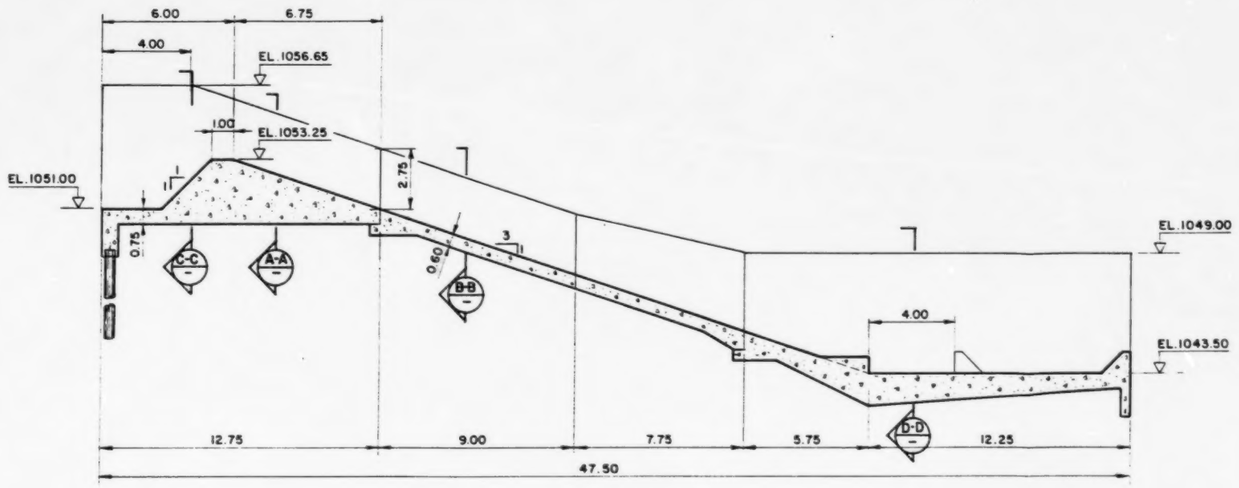
WILLOW CREEK PROJECT

PINE COULEE RESERVOIR

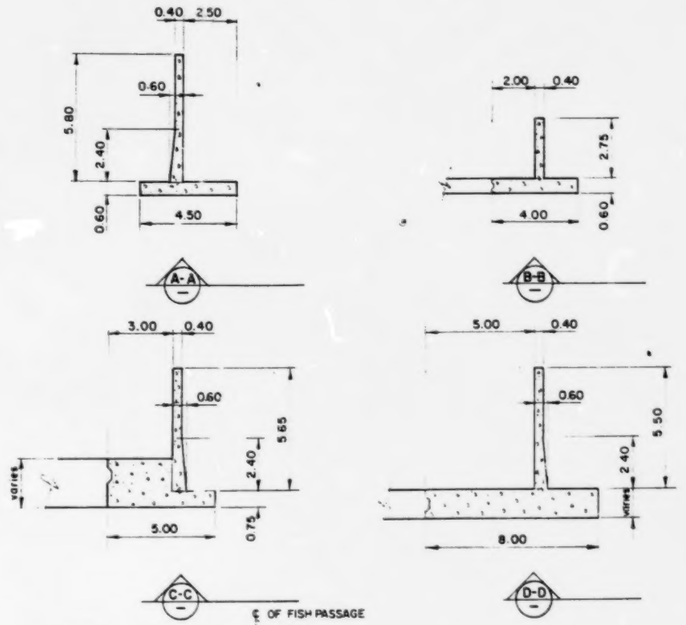
OUTLET WORKS RATING CURVE FOR 60" x 84" SLUICE GATE

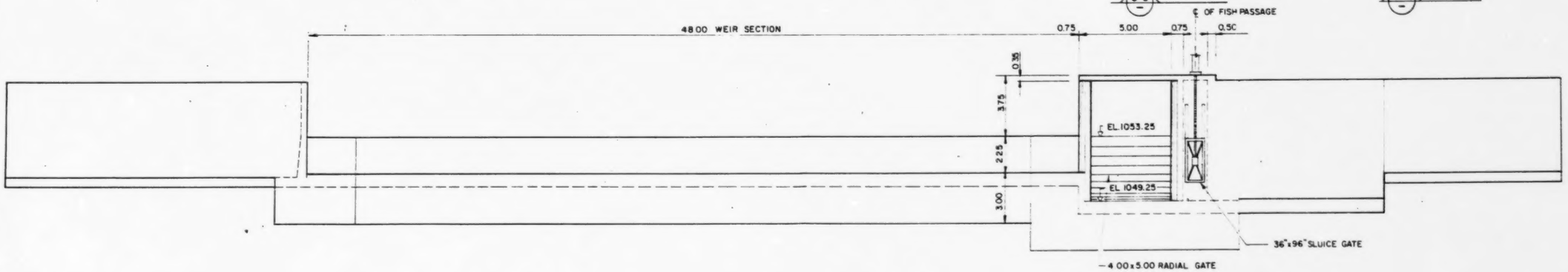
AS SHOWN

AUG., 1985



℄ WEIR SECTION





FRONT ELEVATION

MARK	NATURE OF REVISION	DATE	ENG.	DWN.
1				
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Alberta ENVIRONMENT — DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN
DATE	CHECKED

WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

DIVERSION WEIR

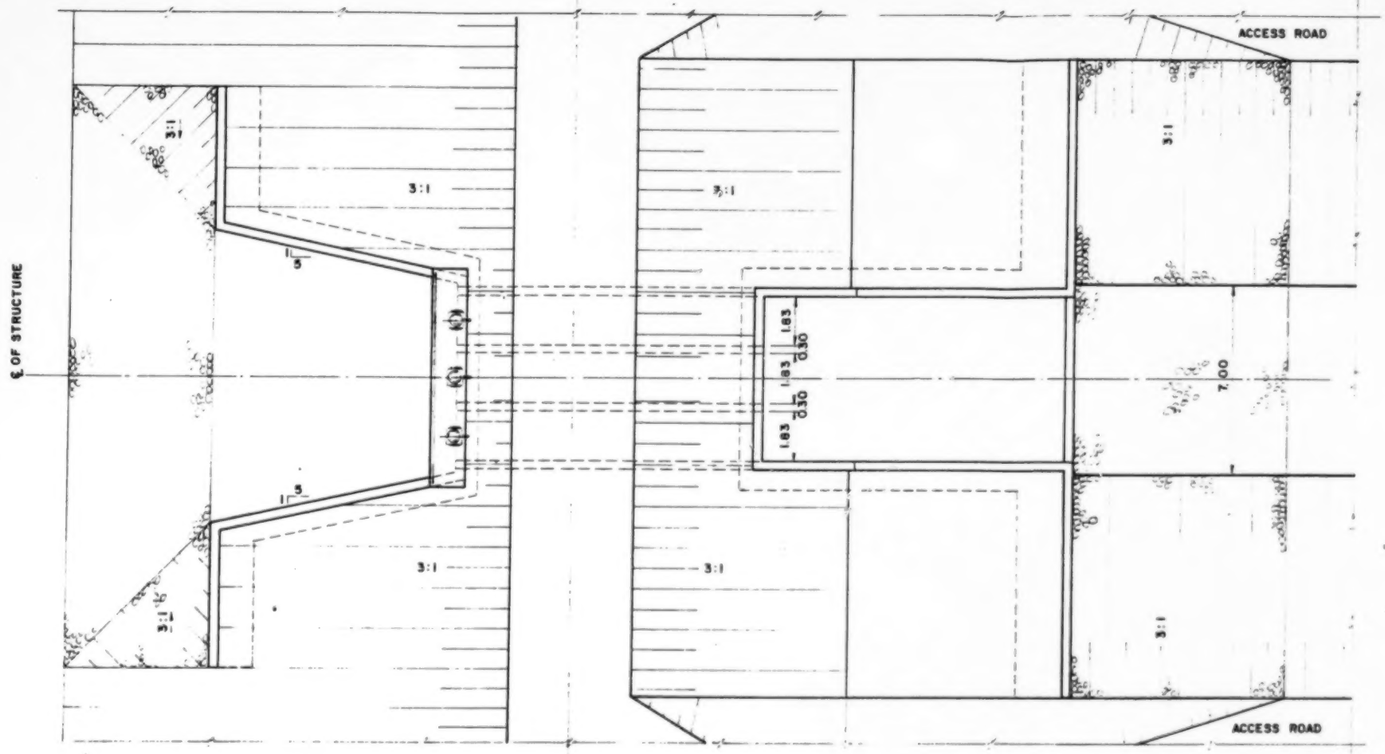
SCALE 1:125 — SHEET 9 OF
DATE AUGUST, 1985 — DWG No

MICROFILM DATE
DRAWING FILE No.
CENTRAL FILE No.
P1-560x860 H-E

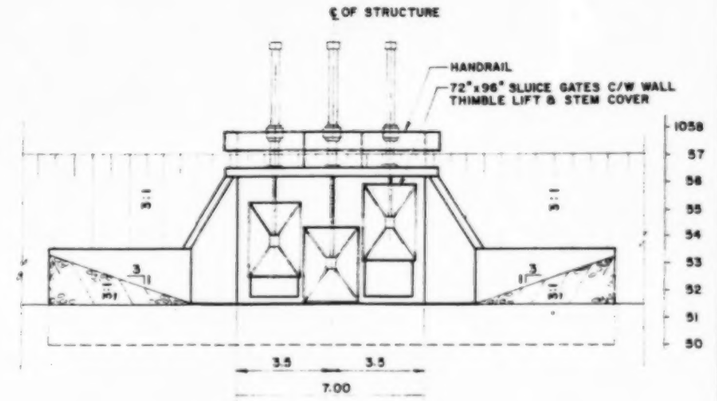
MICROFILM DATE

DRAWING FILE No.

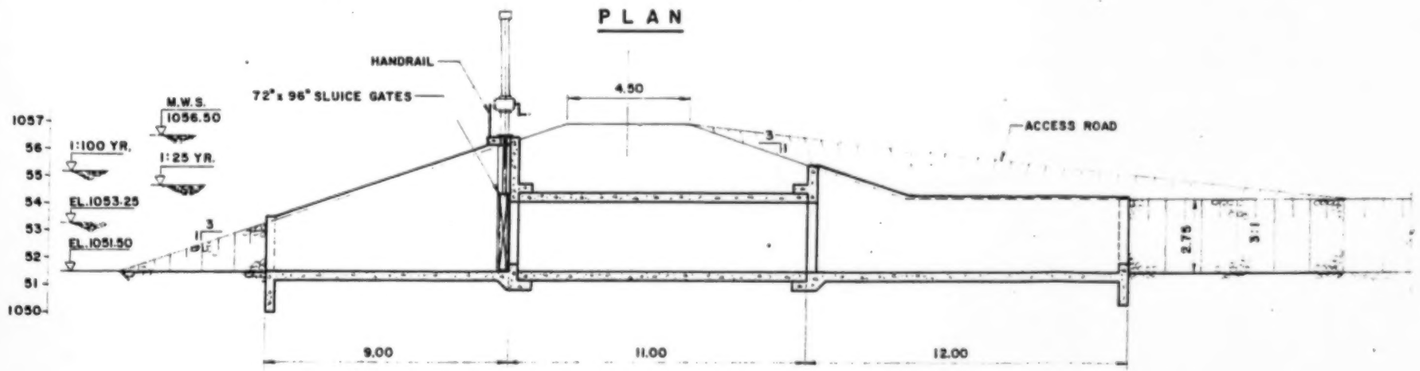
CENTRAL FILE No.



PLAN



UPSTREAM ELEVATION



CENTRE LINE SECTION

MARK	NATURE OF REVISION	DATE	ENG.	DWN.
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Alberta ENVIRONMENT DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED
DATE	CHECKED
*APPROVED	DRAWN
DATE	CHECKED

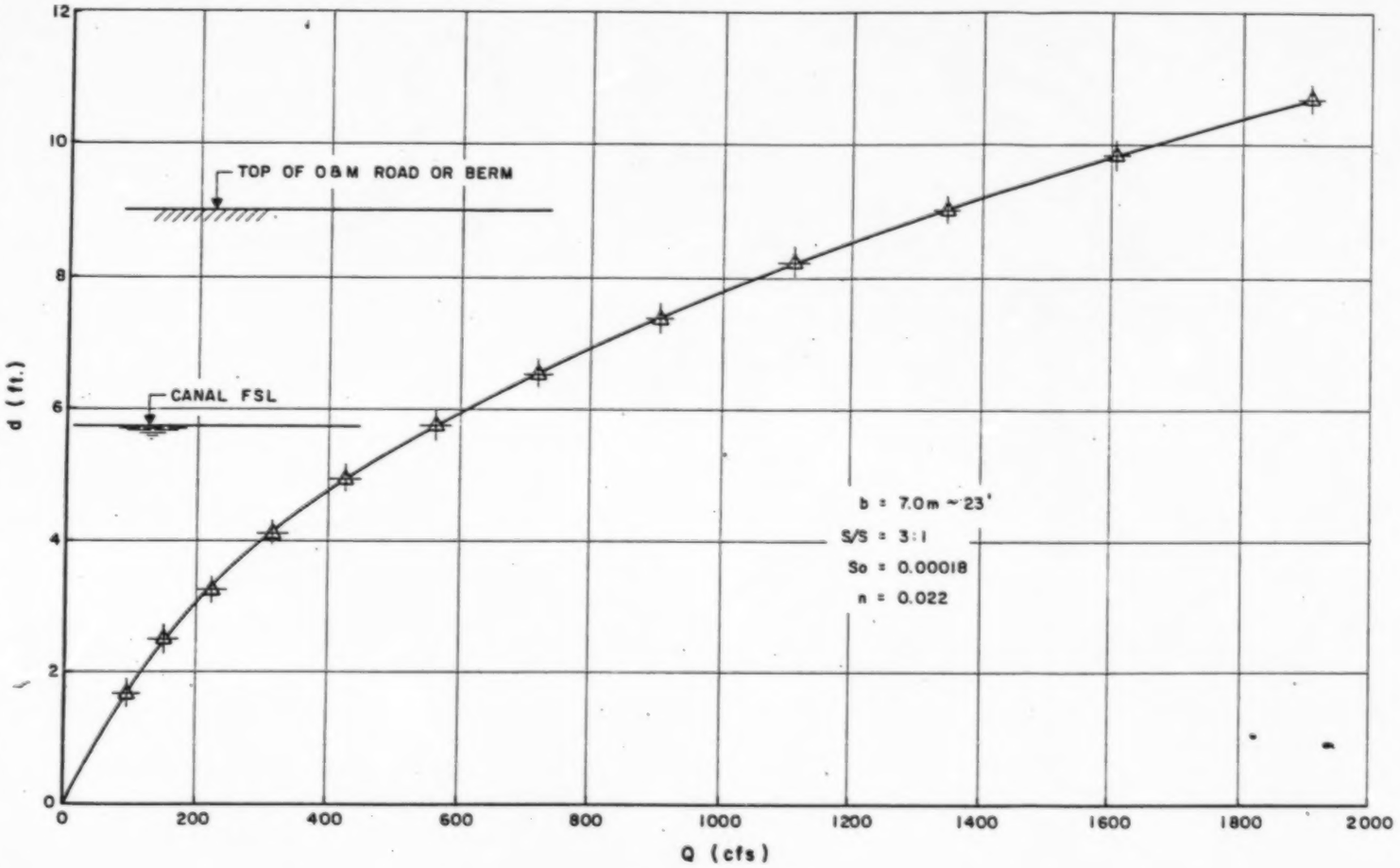
WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

HEAD GATES

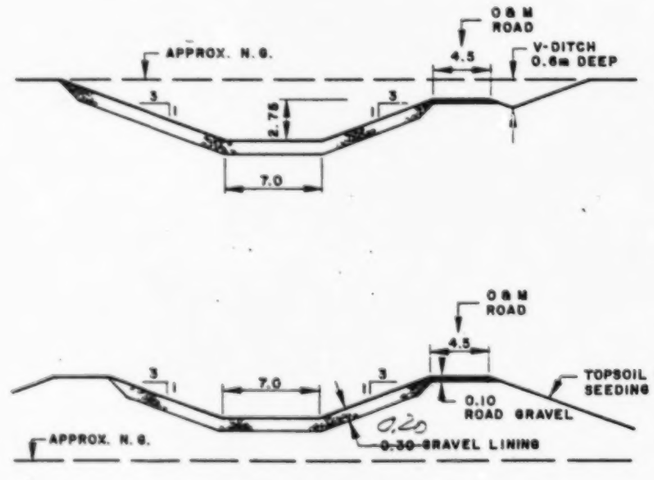
SCALE 1:100 | SHEET 10 OF
DATE AUGUST, 1985 | DWG. No.

P1-560x860 H | H-E

G F E D C B A



RATING CURVE
(Imperial Units)



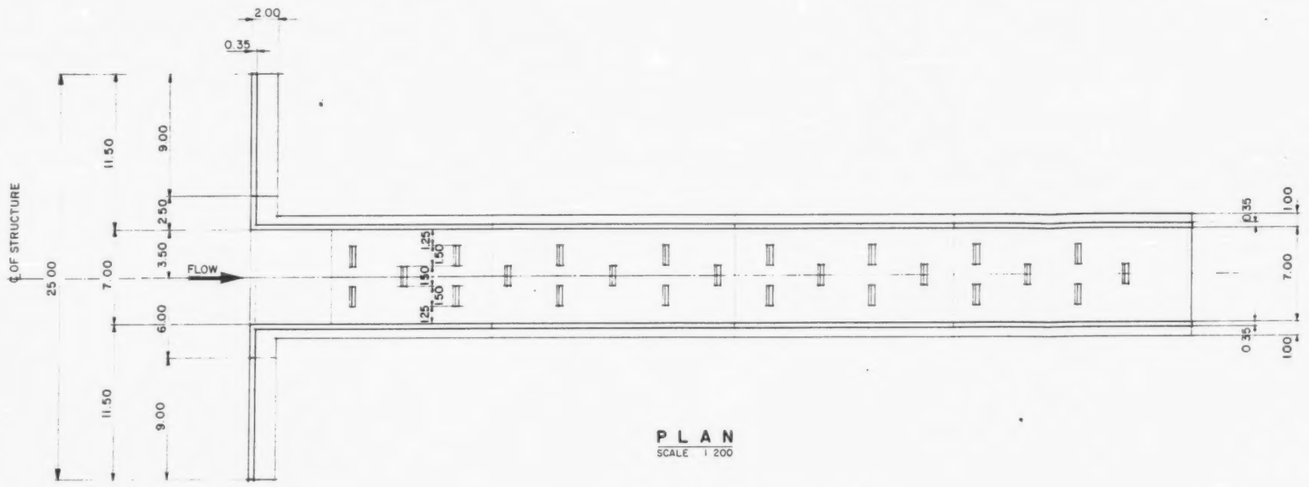
PINE COULEE
CROSS SECTIONS

Alberta ENVIRONMENT DESIGN AND CONSTRUCTION DIVISION		WILLOW CREEK PROJECT
		PINE COULEE RESERVOIR
SUBMITTED	DESIGNED	DIVERSION CANAL
DATE	CHECKED	
APPROVED	DRAWN B. Sanders	SCALE AS SHOWN SHEET 11 OF
DATE	CHECKED /	DATE AUG., 1985 DRAWING No

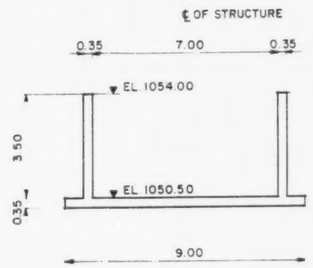
MICROFILM DATE
DRAWING FILE No.
CENTRAL FILE No.

P3-280×430

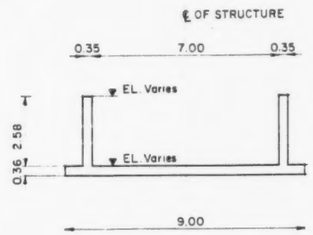
MICROFILM DATE
DRAWING FILE No.
CENTRAL FILE No.



PLAN
SCALE 1:200

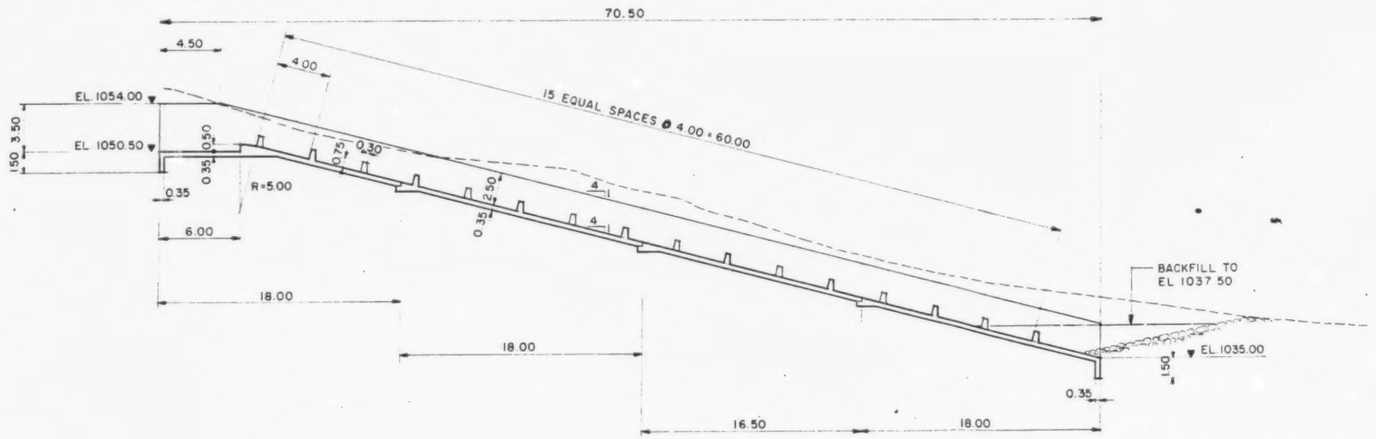


INLET



CHUTE

CROSS SECTIONS
SCALE 1:100



CENTRE LINE SECTION
SCALE 1:200

MARK	NATURE OF REVISION	DATE	ENG.	DWN.
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Alberta ENVIRONMENT DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN
DATE	CHECKED

WILLOW CREEK PROJECT
PINE COULEE RESERVOIR
RESERVOIR INLET PLAN and SECTIONS

SCALE AS SHOWN	SHEET 12 OF
DATE AUGUST, 1985	DWG No

P1-560x860 M H-E

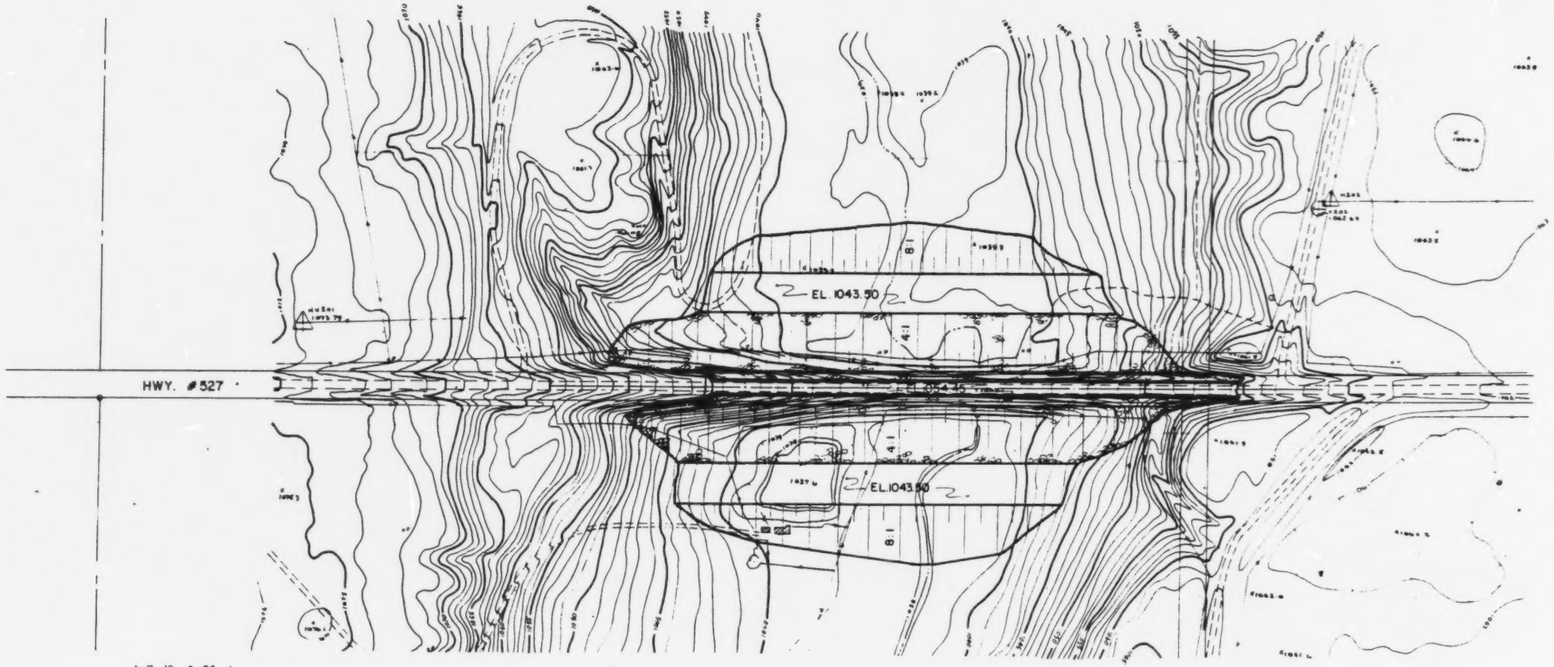
MICROFILM DATE

DRAWING FILE No

CENTRAL FILE No

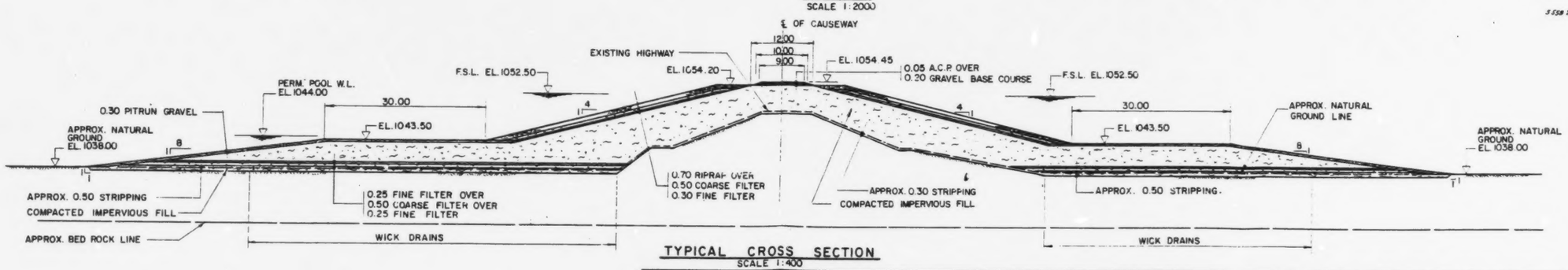
0 10 20 40 60 80 100

S.E. 15-14-28-4



N.E. 10-14-28-4

PLAN
SCALE 1:2000



TYPICAL CROSS SECTION
SCALE 1:400

MARK	NATURE OF REVISION	DATE	ENG.	DWN.
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Alberta ENVIRONMENT — DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED
DATE	CHECKED
APPROVED	DRAWN
DATE	CHECKED

WILLOW CREEK PROJECT
PINE COULEE RESERVOIR

CAUSEWAY @ HIGHWAY # 527

SCALE AS SHOWN	SHEET 13 OF
DATE AUGUST, 1985	DWG No

P1 - 680 x 860

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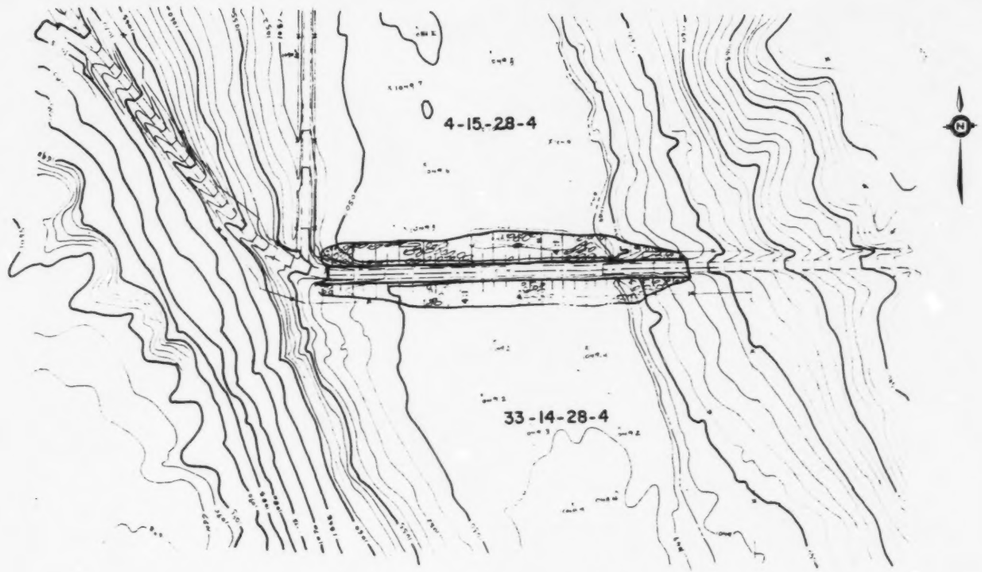
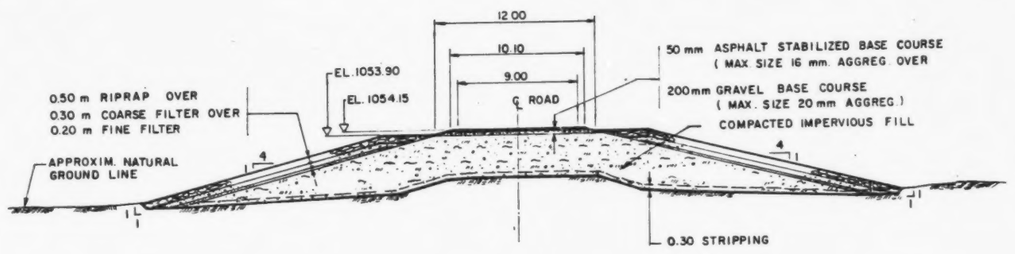


PLAN
1:2 000



TYPICAL CROSS SECTION
1:200

MARK	NATURE OF REVISION	DATE	ENG.	DWN.
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Alberta ENVIRONMENT — DESIGN AND CONSTRUCTION DIVISION

SUBMITTED	DESIGNED .....
DATE	CHECKED .....
APPROVED	DRAWN F. Fjordbakken
DATE	CHECKED .....

WILLOW CREEK PROJECT
PINE COULEE RESERVOIR
CAUSEWAY E.-W. ROAD
N. BDY. OF 33-14-28-W4

SCALE AS SHOWN	SHEET 14 OF
DATE AUGUST, 1985	DWG No

MICROFILM DATE
DRAWING FILE No
CENTRAL FILE No
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